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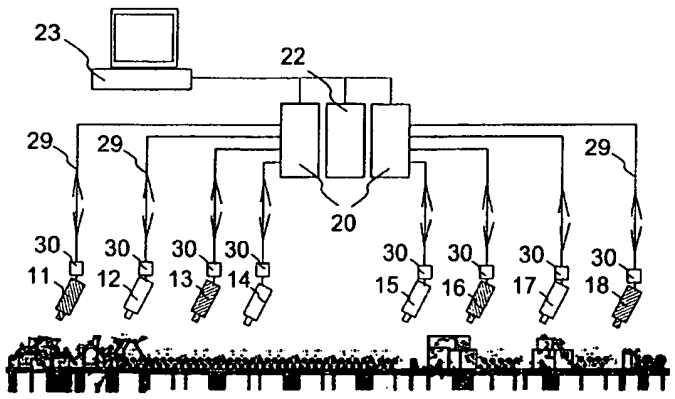
(54) Title: FLEXIBLE CAMERA INTERFACE



(57) Abstract: The invention relates to a method for coupling a camera unit (11-18) to communicate with an image processing unit (20) that represents and/or analyzes and/or stores image information in a system monitoring the manufacturing or finishing process of a continuous fibrous web, said control system comprising one or several camera units (11-18) connected to at least one image processing unit (20). In the camera interface according to the invention an image signal (31, 40, 50) received from a single camera unit (11-18) is transformed in the vicinity of said camera unit (11-18) into a series mode digital signal (38) which has a standard frame structure and is independent on the type of the camera unit, and said series mode signal (38) with a standardized frame structure is transmitted further to the image processing unit of the control system by means of undisturbed optical connection (29). Thus, by means of the invention the interface used for transmission of data is standardized in the signal receiving end, i.e. in the image processing unit (20) both for the part of its transfer path and for the part of the format used in the transfer path for transmission of data. When compared to the related art, the invention enables a more flexible and undisturbed coupling of camera units of different types to a control system when building up, modernizing or adjusting said system to changing operating conditions.

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FLEXIBLE CAMERA INTERFACE

Field of the invention

The invention relates to a method according to the preamble of the appended claim 1 for coupling a camera unit to communicate with an image processing unit that processes image information in a system monitoring the manufacturing or finishing process of a fibrous web. The invention also relates to a camera interface according to the preamble of the appended claim 3 for implementing the method.

Background of the invention and prior art

There is a constant aim to increase the web speeds utilized in the manufacturing and finishing processes of paper, paperboard and other corresponding web-like materials in order to improve the production rate of said processes. When the web speeds are increased, it is, however, necessary to monitor the function and state of the process in more detailed manner than before in order to avoid an increase in web breaks that impair production rate and in different kinds of quality flaws of the fibrous web.

The use of electric array cameras and line scan cameras is a method that has been found to be very efficient in implementing real-time monitoring of a rapidly moving fibrous web and its path. By means of cameras it is possible to monitor a target optically without contact simultaneously over a wide area, for example over the entire transverse width of the web, and by using several different camera units it is possible to monitor the fibrous web and its path at several points of the process in the machine direction.

One example of commercially available systems suitable for real-time camera monitoring of the paper web is the so-called Sensodec WRM™ system in which system there may be even several dozens of camera units arranged to image the paper web and its path at different points of the process. The basic principle of the system is shown in Fig. 1. The camera units 11 to 18 may be placed according to the needs at

different points of the process, from the wet end of the paper machine all the way to the reeling up process. Single camera units that are used in the system are at present typically CCD cameras (Charged Coupled Devices) that produce an analog video signal 24 which is transmitted to computers functioning as image processing units 20, 22 for image capturing (transformation of the image into digital format), storing, digital image processing and analysis. The results of the image analysis can be examined in a user interface 23 placed in a control room, and the image produced by the camera units 11 to 18 can be examined in its unprocessed form also in real time, if necessary, by means of video monitors placed in the control room.

Rapid development of the camera technology has, however, resulted in that there are a vast number of different camera types available at the moment, and new camera detectors equipped with even better features are constantly introduced on the market. The properties of the cameras vary for example according to the number of pixels, photosensitivity, wavelength and the available shutter times of the detector part. Single camera can give an image signal as an output either as a conventional analog video signal or at present also directly in digital format.

In the process control system of the above type that contains several, even dozens of camera units, it is, of course, always reasonable to select the camera type with the most suitable properties and performance for a given control point. In certain sections of the process, it is for example reasonable to use an affordable CCD camera of a conventional type having only a relatively good image quality (for example the pixel resolution and the number of reproducible grey tones) and producing analog video signals, whereas in a more critical point of the process it may be necessary to use a more expensive digital camera having higher resolution and image frequency and outputting the image signal directly in digital format. In certain applications it is sufficient instead of an array camera to use a line scan camera.

If different types of cameras are to be coupled to the same control system, it is thus necessary to equip the control system with camera interfaces that are arranged suitable for each camera type. In other

words, the image processing unit or units of the system must be equipped with several different camera interfaces to make it possible to couple different types of cameras to the system. This makes the structure of the control system significantly more complex, and thus also increases the costs of the system. At the same time it is difficult to update the properties of the system by replacing certain outdated or inoperative camera units with newer cameras, for example CCD cameras producing analog video signal with newer digital CCD cameras, because in addition to mere replacement of the cameras, other significant changes must always be made to the system as well.

Thus, there is a clear need for a solution that enables a more flexible coupling of camera units of different types to a control system when building up, modernizing or adjusting said system to changing operating conditions.

Basic principle and most important advantages of the invention

The primary purpose of the present invention is to introduce a new solution for coupling an electric camera unit to communicate with an image processing unit that processes image information in a system monitoring the manufacturing or finishing process of a continuous fibrous web in such a manner that by means of the invention it is also possible to easily couple and replace different types of cameras in said system.

To attain this purpose, the method according to the invention is primarily characterized in what will be presented in the characterizing part of the independent claim 1.

The camera interface according to the invention, in turn, is primarily characterized in what will be presented in the characterizing part of the independent claim 3.

The other, dependent claims will present some preferred embodiments of the invention.

The essential new basic idea of the invention is that to couple a single camera unit to communicate with an image processing unit that represents, analyses, stores and/or otherwise processes image information, a special camera interface is now utilized, said camera interface being characterized in that the image signal attained from the camera unit is in the immediate vicinity of said camera unit transformed into digital series mode signal having a certain standardized frame structure, and said signal is transmitted via an optical connection further to the image processing unit that is located farther off in the system. By means of the invention the interface used for transmission of data is standardized in the signal receiving end, i.e. in the image processing unit both for the part of its physical transfer path as well as for the format (frame structure) used in the transfer path for transmission of data, wherein changes are not necessary in the receiving end when the camera unit transmitting the signal is changed.

In a preferred embodiment of the invention the camera interface is arranged to be implemented by means of a transfer unit placed in the vicinity of the camera unit, which single transformer unit can be further adapted i.e. configured to be used together with several different camera types, wherein the same transformer unit is suitable to be used for connecting different types of cameras to the same control system.

In a preferred embodiment of the invention the optical connection between the camera unit and the image processing unit is formed as a duplex connection, wherein the settings of the camera unit can be changed and adjusted either fully automatically under the control of the control system, or manually by a user interface of the control system placed in a control room or the like. To perform the aforementioned actions it is thus not necessary to go over to the camera unit to the vicinity of a process that typically contains many elements of danger that impair occupational safety.

By means of the invention it is possible to attain several very significant advantages when compared to prior art, the most significant of said advantages being described briefly in the following.

The use of a digital and series mode optical signal according to the invention enables a completely undisturbed signal transmission even over longer distances (hundreds of meters) in an industrial environment that is quite prone to disturbances as such. When an analog video signal of prior art (for example PAL, CCIR, NTSC, RS-170) is transmitted via a coaxial cable or another galvanic connection, disturbances are always induced in said signal in such an environment, said disturbances significantly weakening the image quality in longer transmission connections. Without special arrangements, for example repeater amplifiers, the analog video signal also tends to attenuate in long cables, thus weakening the image quality. In digital cameras known in the state of the art where a digital interface is used (for example RS-422, RS-644, FireWire™, Cameralink™), problems relating to the present control system applications are caused by insufficient cabling distances, which are typically only in the order of 10 to 20 meters at the highest. High frequency digital signal in electric format cannot be transferred long distances via a galvanic connection without excessive attenuation of the signal, and it is well known that these electric digital connections are also very sensitive to disturbances induced in galvanic transfer cables. The state of the art also discloses the transfer of image signal optically via an optical fibre, but such prior art arrangements that are suitable for longer transfer distances are only intended for a predetermined single camera or signal types, and thus it is not possible to use them to replace the camera interface according to the invention whose essential feature is its applicability for several different camera types, for example analog or digital cameras.

The invention also enables the use of so-called high image frequency cameras that deviate from standard analog image frequencies (e.g. 25 or 30 images per second) as a part of the control system of the process, because the camera interface according to the invention is also capable of transmitting high frequency image signals produced by these camera types. High frequency analog or digital signal cannot be transferred sufficiently long distances by means solutions according to the state of the art without excessive attenuation of the signal.

The invention also makes it possible to utilize a so-called pixel clock that is available in the electronics of present day cameras in the act of digitizing the image, which significantly improves the quality of an image presented in digital format.

The invention also eliminates the need to place different kinds of image capturing cards into the image processing unit, because the digitizing of the image signal, if necessary, is conducted already in the vicinity of the camera unit. The digital, series mode signal according to the invention with a standardized frame structure can be input directly to a computer functioning as a image processing unit, or to a DSP device (Digital Signal Processing).

The following, more detailed description of the invention with examples will more clearly illustrate, for anyone skilled in the art, advantageous embodiments of the invention as well as advantages to be achieved with the invention in relation to prior art.

Brief description of the drawings:

In the following, the invention will be described in more detail with reference to the appended drawings, in which

Fig. 1 shows, in principle, a system according to the state of art that is suitable for real-time camera monitoring of the paper web,

Fig. 2 illustrates in principle the act of applying the camera interface according to the invention in a control system according to Fig. 1,

Fig. 3 shows, in principle, a possible configuration of the camera interface according to the invention,

Fig. 4 shows, in principle, a second possible configuration of the camera interface according to the invention, and

Fig. 5 shows, in principle, a third possible configuration of the camera interface according to the invention.

Detailed description of the invention

Fig. 1 shows in principle a system intended for real time camera monitoring of a paper web, to which system reference was briefly made hereinabove in the section describing the state of the art.

In Fig. 1 the camera unit 11 – 18 placed in the vicinity of the process to be monitored outputs an analog video signal 24 that is conveyed further to an image processing unit 20 placed in an electric room or in a corresponding device room. The image processing units 20 comprise an image capturing card 21 separately for each camera unit 11 – 18, to convert the analog video signal into digital format. For this purpose, the image capturing cards 21 can also be replaced with DSP cards programmed in a suitable manner.

The image processing units 20 may be connected further to a separate main unit 22, if necessary, in which main unit the images stored in digital format are analysed in more detail. By means of a user interface 23 placed in a control room or the like, it is possible for the user to monitor the results of the image analysis and control the operation of the control system. If necessary, the image produced by the camera units 11 to 18 can also be examined in its unprocessed form in real time by means of video monitors placed in the control room, the analog video signal produced by the camera units being conveyed to said video monitors (not shown in Fig.).

In the control system of Fig. 1, the replacement of a single camera unit, for example the camera unit 11 with a newer camera unit producing digital signal also requires changes in the receiving end in addition to the replacement of the camera unit. In other words, the image capturing card 21 placed in the image processing unit 20 must be replaced with a card that accepts digital signal, and typically the software of the image processing unit 20 must be updated because of said replacement of the image capturing card. Furthermore, it is likely that the

cabling 24 must be replaced with a cabling that is better suitable for transmission of a digital signal. Furthermore, the maximum length of the cabling 24 is now determined by the disturbances caused by the attenuation of the signal and disturbances induced to the signal from the environment.

Fig. 2 shows in principle the solution according to the invention in a system intended for real time camera monitoring of a paper web.

According to the invention, the image signal received from the camera units 11 to 18 is transformed into an optical series mode signal with a standardized frame structure in the immediate vicinity of each said camera unit by means of a transformer unit 30. From the transformer unit 30 the optical signal is transmitted via an optical connection 29, i.e. typically via an optical fibre connection to the actual image processing unit 20.

According to a preferred embodiment of the invention the transformer units 30 are implemented in such a manner that the same single transformer unit 30 can be easily configured so that it can be used together with several different camera types. Thus, in Fig. 2 for example the camera unit 11 can be a digital camera that inputs digital image signal to the transformer unit 30 and the camera unit 12 can be an analog video camera that inputs analog video signal to the transformer unit 30. In both aforementioned cases the series mode signal transmitted to the image processing unit 20 via the optical connection 29 complies with the same standardized frame structure, wherein in view of the receiving end, the interface used for data transmission is constant both for the part of its physical transfer path and for the format used in the data transmission. This makes it possible to select the camera types of the camera units 11 to 18 so that they are always best suitable for each control point and purpose as far as their properties and performance are concerned.

If there is for example only one high speed camera in use in the paper mill for reasons relating to the costs, the invention now makes it possible to place said special camera according to the needs to a desired

control point, for example to determine a special problem occurring at that point. The replacement and implementation of the camera unit do not require other substantial changes in the control system.

The use of an optical connection 29 for signal transmission in accordance with the invention also enables a completely undisturbed signal transmission even over longer distances (hundreds of meters) in a paper machine environment that is quite prone to disturbances. The invention also eliminates the need to place separate image capturing cards in the image processing units 20, because the digitizing of the image signal, if necessary, is according to the invention conducted already in the transformer unit 30 placed in the vicinity of the camera units 11 to 18. The digital, series mode signal according to the invention can be input directly to a computer functioning as an image processing unit 20, or to another DSP device.

In the following, the function of the transformer unit 30 in its various configurations is described in more detail.

Figure 3 shows, in more detail, a transformer unit 30 implementing the camera interface according to the invention, as well as a certain configuration of the same.

In Fig. 3, a horizontal H and vertical V synchronization of the image as well as the actual analog video signal A containing image information of successive lines are separated by means of a video decoder 32 in a manner known as such from a composite video signal 31 received from the camera unit 11 – 18. The analog video signal A is digitized in an A/D converter 33 and it is input to a series transformer 34. The synchronization information H, V relating to the image is transformed into digital format by means of programmable logic 35 and it is input further to the series transformer 34. In the series transformer 34 the synchronization information H, V relating to the image, as well as the image information A of the lines of the image are now combined into a standardized series mode frame structure 38, which frame structure is transmitted further to the optical fibre 37 and to the image processing unit by means of an optical transmitter 36.

In said standardized frame structure it is possible to use for example frames composed of words of 16 bits, and in each frame image information (signal A) transformed into digital format is transmitted in 8 to 10 bits, information on the beginning of a line (horizontal synchronization H) in one bit, information on the beginning of the image field (vertical synchronization V) in one bit, and information indicating whether the field is an even or uneven field in one bit. When for example 10 bits are allocated in the frame for representing image information (signal A), it is possible to represent 2^{10} different signal levels.

It is obvious that the above-presented frame structure is only an example of a possible frame structure to be used in connection with the invention. In view of the invention, the only essential aspect is the fact that the series mode frame structure used in the transmission of data is standardized for the receiving end, wherein any frame structure suitable for the purpose can, in principle, be selected and standardized as a frame structure.

According to the invention, when the frame structure used in the transmission of image information is standardized, the receiving end, i.e. the image processing unit 20 can now merely on the basis of the information transmitted by the standardized frame structure break up the received series mode information into images again, and the image processing unit 20 does not have to be aware of the detailed properties of the camera unit 11 – 18 that transmits the image. When the receiving end has received a sufficient amount of frames, the receiving end can utilize the horizontal and vertical synchronization information to determine for example the size of the image, in other words the number of pixels contained in the image in horizontal and vertical direction. The aforementioned properties of the received images can thus be determined in the interface of the receiving end merely on the basis of the properties of the received signal.

In a preferred embodiment of the invention, the connection between the camera unit 11 – 18 and the image processing unit 20 is established in duplex format, wherein the image processing unit 20 can

transmit to the camera unit 20 or to the peripheral devices of the camera unit commands relating to their setting and adjustment. Figure 4 shows in principle a configuration of the transformer unit 30 implementing the duplex camera interface.

In the situation of Fig. 4, the optical connection 29 between the camera unit 11 - 18 and the image processing unit 20 comprises in addition to the optical fibre 37 also an optical fibre 41 that transmits the signal towards the camera unit 11 – 18. The optical signal received from the optical fibre 41 is received in a receiver 42, from which the information in digital format is transmitted further to a microcontroller 43. The microcontroller 43 is also programmed to control the settings 44, 46 of the camera unit or its peripheral devices in accordance with the instructions it receives.

The settings of the camera unit that can be controlled in the aforementioned manner can in analog cameras include for example gamma control, settings of automatic gain control (AGS), shutter time, and settings of white balance and colour saturation. In digital cameras it is also possible to adjust for example the pixel size of the image, the digitizing settings of the image and image frequency. Furthermore, it is possible to adjust peripheral devices such as the motorized optics of the camera unit (focusing, zoom, aperture), the position of the motorized camera housing and/or a separate light source located in connection with the camera unit.

When the settings of the camera and the settings of the light source used in the imaging are adjusted together by the camera interface according to the invention, it is possible to adjust the sensitivity of the camera unit optimally with respect to the lighting in use to attain the best possible image quality. Thus, the invention enables for example a mutual timing of the light source and the camera unit in such a manner that the intensity of light transmitted by the light source at the image frequency used at a given time is essentially the same for all images. By means of said synchronization it is thus possible to prevent the weakening of image quality that is caused by strong variation of lighting in successive images of a particular camera unit, when the intensity of

the light transmitted by the light source used in the imaging varies in proportion to the network frequency, and the image frequency of said camera unit is not synchronized with this variation.

The microcontroller 43 can be programmed to transmit the commands received from the image processing unit to the proper actuators (for example the motors of the optics and the camera housing), and to the camera used in the camera unit for example in a signal in RS-232 format or in another format suitable for the purpose. To an external light source the microcontroller 43 can transmit for example synchronization pulses of TTL level.

In Fig. 4, a broken line shows a situation in which a video signal 40 that is already in digital format is input from the camera unit 11 – 18 to the transformer unit 30 instead of an analog composite video signal 31. Thus, said video signal 40 can be input directly to the series transformer 34 that transforms the signal into a signal with a standardized frame structure in accordance with the invention. The digital video signal 40 obtained from the camera unit is typically a parallel mode signal, but it can also be a series mode signal.

Figure 5 shows in principle yet another possible configuration of the transformer unit 30.

The transformer unit 30 of Fig. 5 is suitable for a situation in which the transformer unit is supplemented with a camera unit 11 – 18, in which a so-called pixel clock 45 is also available as an output in addition to the analog video signal 50 (signal A) and separate analog horizontal and vertical synchronization signals 51, 52 (signals H and V). The pixel clock 45 is a clock signal used in the synchronization of the inner function of the camera, by means of which it is possible to improve repeatability when digitizing an analog video signal in a manner known as such so that in successively digitized images the pixel corresponding to the same point in the image area always ends up precisely to the same point in the digitized image. This factor that improves the precision in digitizing images is important in applications in which digital image processing is utilized to detect changes occurring

as functions of time in the target. By conveying the pixel clock signal 45 in accordance with Fig. 5 to the A/D converter 33, it is possible to synchronize the transformation of the video signal A into a digital format in the A/D converter in such a manner that the alignment of pixels in the image area remains constant in successive images.

The transformer units 30 presented in Figs 3 to 5 thus constitute one and the same transformer unit in a preferred embodiment of the invention, which transformer unit can be configured so that it is suitable for use with different types of camera units by means of settings performed for example in said transformer unit with switches or through software. Thus, in the control system of Fig. 2, all transformer units 30 are identical, and only configured to function in connection with different kinds of camera units 11 – 18 by means of different settings.

The invention is not restricted solely to the aforementioned embodiment, but it is, in principle, also possible to manufacture the transformer units 30 separately for different types of camera units without the aforementioned configuration possibility. Thus, when the type of the camera unit changes, it is, however, always necessary to change the corresponding transformer unit 30 as well. According to the invention, other changes, such as changes in the cabling 29 or in the image processing unit 20, are in that case not necessary in the control system either, because the interface used for transmission of data remains constant in the receiving end both for the part of its physical transfer path and for the part of the format used in the transfer path.

The invention is not restricted to be used solely in camera detectors based on the CCD technology, but it can naturally be applied in other detectors, such as CMOS detectors (Complementary Metal Oxide Semiconductor). The camera units can thus be cameras of visible wavelength region, but cameras of ultraviolet and infrared region can also be coupled to the control system by means of the invention. The invention is suitable for cameras equipped with a two-dimensional array detector as well as for so-called line scan cameras equipped with one-dimensional array detector. The cameras that are used may be either grey tone cameras or cameras complying with any other colour

system. Instead of the conventional image transmitting lense optics of the camera unit or in addition to the same, it is possible to use any optical device intended to provide spectral resolving power, for example a grating spectrometer.

In the act of setting up the optical connection 29 it is possible to use for example either a multimode optical fibre or a single mode optical fibre. Advantageously the optical connection 29 is set up by means of a standard multimode optical fibre and standard fibre connectors, and by using components intended for wavelengths of 850 nm or 1300 nm in the optical transmitters and receivers.

The optical data transmission from the camera unit 11 – 18 to the image processing unit 20 and the optical data transmission to the opposite direction from the image processing unit 20 to the camera unit 11 – 18 can be implemented by using a separate optical fibre 37 and 41 for each purpose, but the aforementioned duplex optical connection can also be implemented by means of one optical fibre by utilizing different wavelengths in different transmission directions.

Because the data transmission according to the invention that is conducted via an optical connection 29 is not restricted to any particular image frequency, the invention also makes it possible to supplement the control system with so-called high image frequency cameras that deviate from standard image frequencies (e.g. 25 or 30 images/second). The use of high image frequency cameras enables more accurate monitoring of rapid phenomena occurring in the process. If necessary, it is possible to transform the appropriate parts of the image information obtained from the high image frequency camera in the image processing unit 20 into an analog video signal that can be represented with a video monitor applying normal image frequency.

It is, of course, obvious for anyone skilled in the art that by combining in different ways the principles and modes of operation presented above in connection with different embodiments of the invention, it is possible to provide various embodiments of the invention in accor-

dance with the spirit of the invention. Therefore, the above-presented examples must not be interpreted as restrictive to the invention, but the embodiments of the invention can be freely varied within the scope of the inventive features presented in the claims hereinbelow.

Claims:

1. A method for coupling a camera unit (11 – 18) to communicate with an image processing unit (20) that represents and/or analyzes and/or stores image information in a system monitoring the manufacturing or finishing process of a continuous fibrous web, said control system comprising one or several camera units (11 – 18) connected to at least one image processing unit (20), **characterized** in that in the method

— an image signal (31, 40, 50) received from a single camera unit (11 – 18) is transformed in the vicinity of said camera unit (11 – 18) into a series mode digital signal (38) which has a standard frame structure and is independent on the type of the camera unit, and

— said series mode digital signal (38) with a standard frame structure is transmitted further to the image processing unit (20) of the control system via an optical connection (29),

wherein by means of the method, the interface used in the transmission of image information is standardized in the signal receiving end, i.e. in the image processing unit (20).

2. The method according to claim 1, **characterized** in that the optical connection (29) is established as an duplex data transmission connection in such a manner that it is possible to transmit control information (44, 46) from the image processing unit (20) to the camera unit (11-18) or to the peripheral devices of the camera unit (11-18).

3. A camera interface for coupling a camera unit (11 – 18) to communicate with an image processing unit (20) that represents and/or analyzes and/or stores image information in a system monitoring the manufacturing or finishing process of a continuous fibrous web, said control system comprising one or several camera units (11 to 18) connected to at least one image processing unit (20), **characterized** in that said camera interface is arranged to be implemented by means of a transformer unit (30) placed in the vicinity of each camera unit (11 – 18), said transformer unit (30) comprising at least

— transformer means (34) for transforming an image signal (31, 40, 50) received from the camera unit (11 – 18) into a series mode

digital signal (38) which has a standard frame structure and is independent on the type of the camera unit, and

— connection means (36) for transmitting said series mode digital signal (38) with a standard frame structure further to the image processing unit (20) of the control system via an optical connection (29),

wherein the interface used for transmission of image information is standardized in the receiving end, i.e. in the image processing unit (20) by means of the transformer unit (30) implementing the camera interface.

4. The camera interface according to claim 3, **characterized** in that the transformer unit (30) implementing the camera interface also comprises means (42, 43) for setting up an optical connection (29) as a duplex data transmission connection in such a manner that it is possible to transmit control information (44, 46) from the image processing unit (20) to the camera unit (11-18) or to the peripheral devices of the camera unit (11-18).

5. The camera interface according to claim 4, **characterized** in that the transformer unit (30) implementing the camera interface comprises means (42, 43) for transmitting control information (46) to a light source used in connection with the camera unit (11 – 18) to match and/or synchronize the mutual function of said light source and the camera unit (11 – 18).

6. The camera interface according to any of the foregoing claims 3 to 5, **characterized** in that the transformer unit (30) implementing the camera interface is arranged or said transformer unit (30) can be configured by means of settings to receive the image signal from the camera unit (11 – 18) in analog format (31, 50, 51, 52) and the transformer unit (30) comprises means (33, 35) for transforming said image signal into digital format.

7. The camera interface according to claim 6, **characterized** in that the transformer unit (30) implementing the camera interface also comprises means (33, 35) for utilizing a pixel clock signal obtained as an

output from the camera unit (11 – 18) to transform the image signal into digital format.

8. The camera interface according to any of the foregoing claims 3 to 5, **characterized** in that the transformer unit (30) implementing the camera interface is arranged or said transformer unit (30) can be configured by means of settings to receive the image signal from the camera unit (11 – 18) in digital parallel or series mode (40).

9. The camera interface according to any of the foregoing claims 3 to 8, **characterized** in that the transformer unit (30) implementing the camera interface is arranged or said transformer unit (30) can be configured by means of settings to be used in connection with an array camera.

10. The camera interface according to any of the foregoing claims 3 to 8, **characterized** in that the transformer unit (30) implementing the camera interface is arranged or said transformer unit (30) can be configured by means of settings to be used in connection with a line scan camera.

11. The camera interface according to any of the foregoing claims 3 to 8, **characterized** in that the transformer unit (30) implementing the camera interface is arranged or said transformer unit (30) can be configured by means of settings to be used in connection with a high image frequency camera.

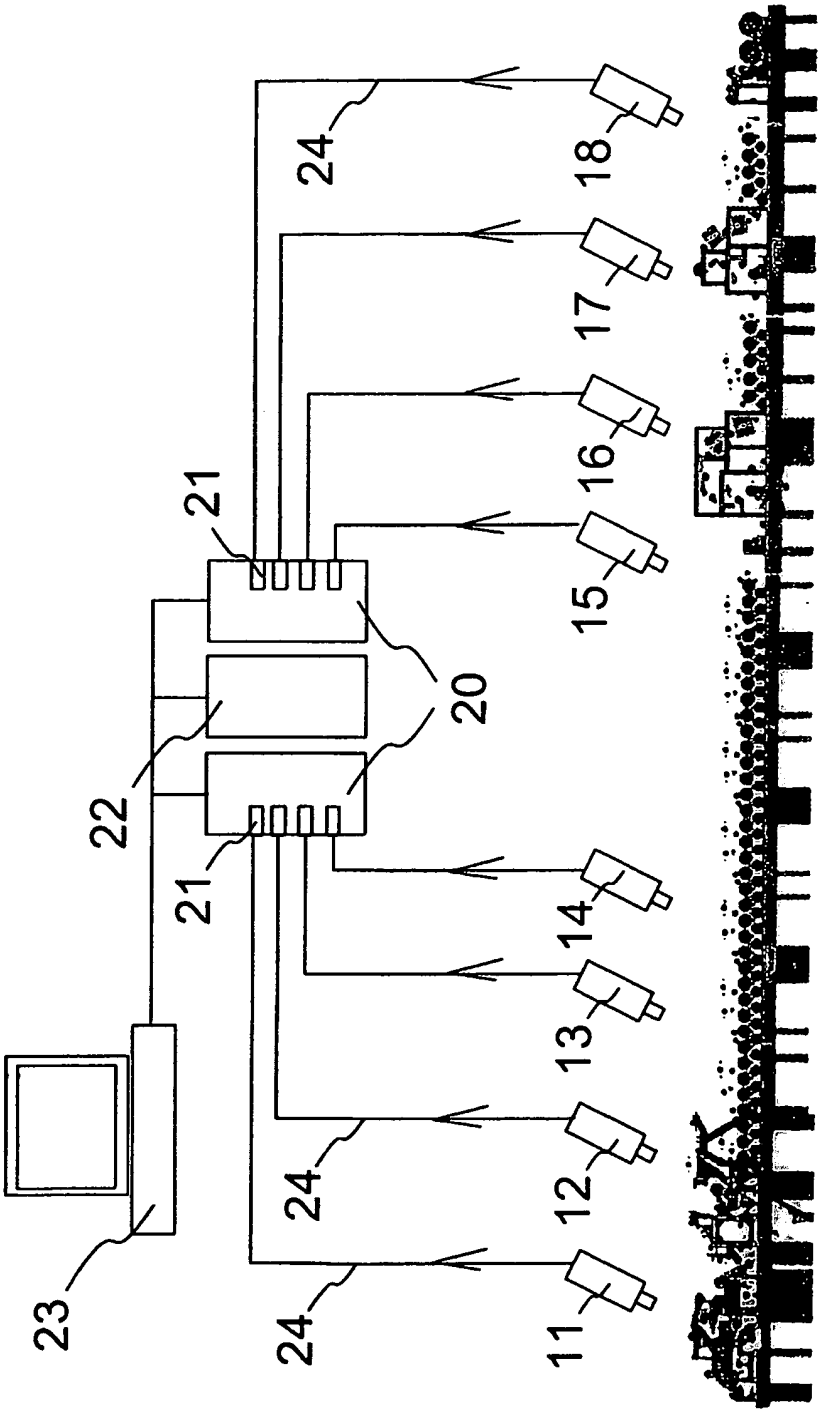


Fig. 1

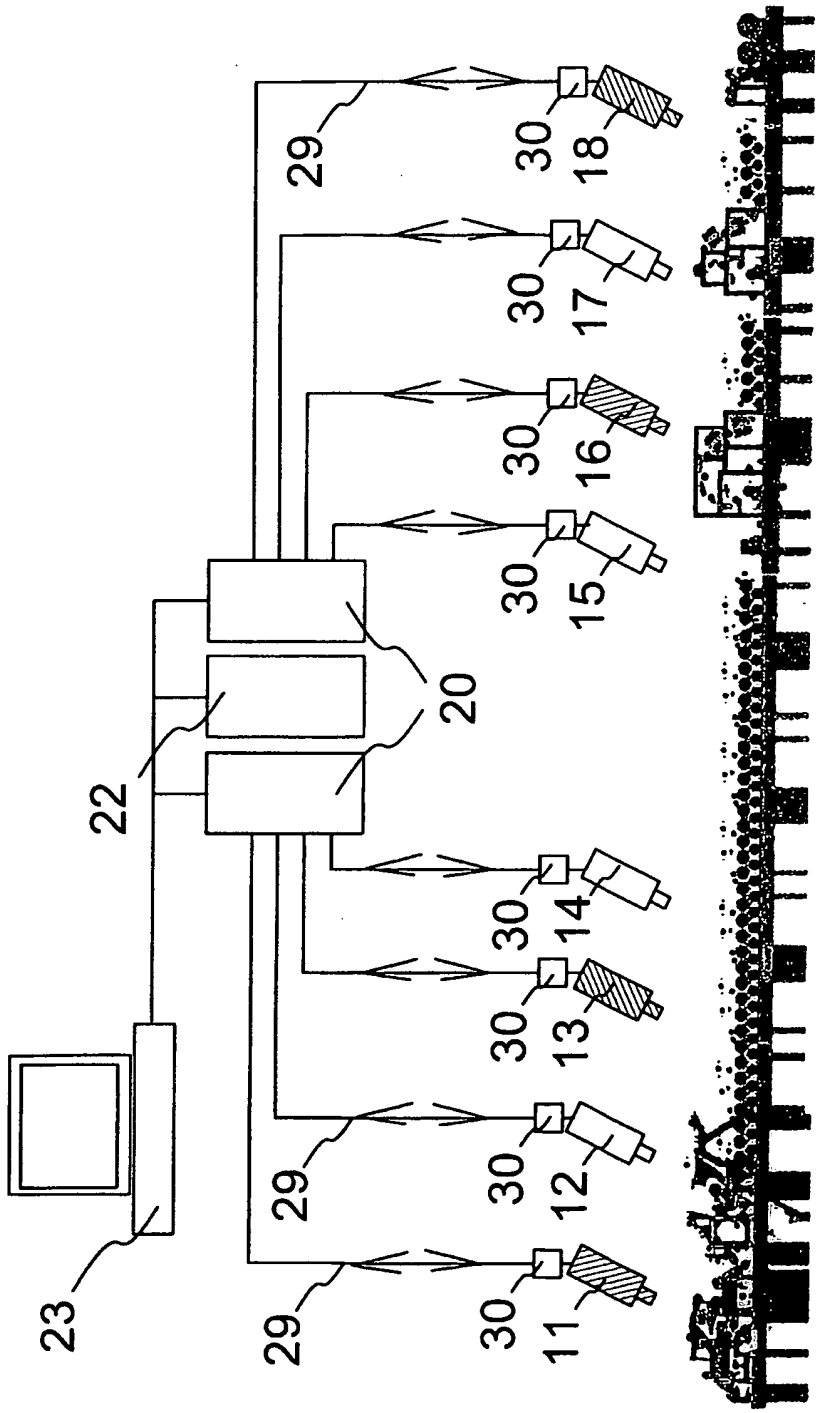


Fig. 2

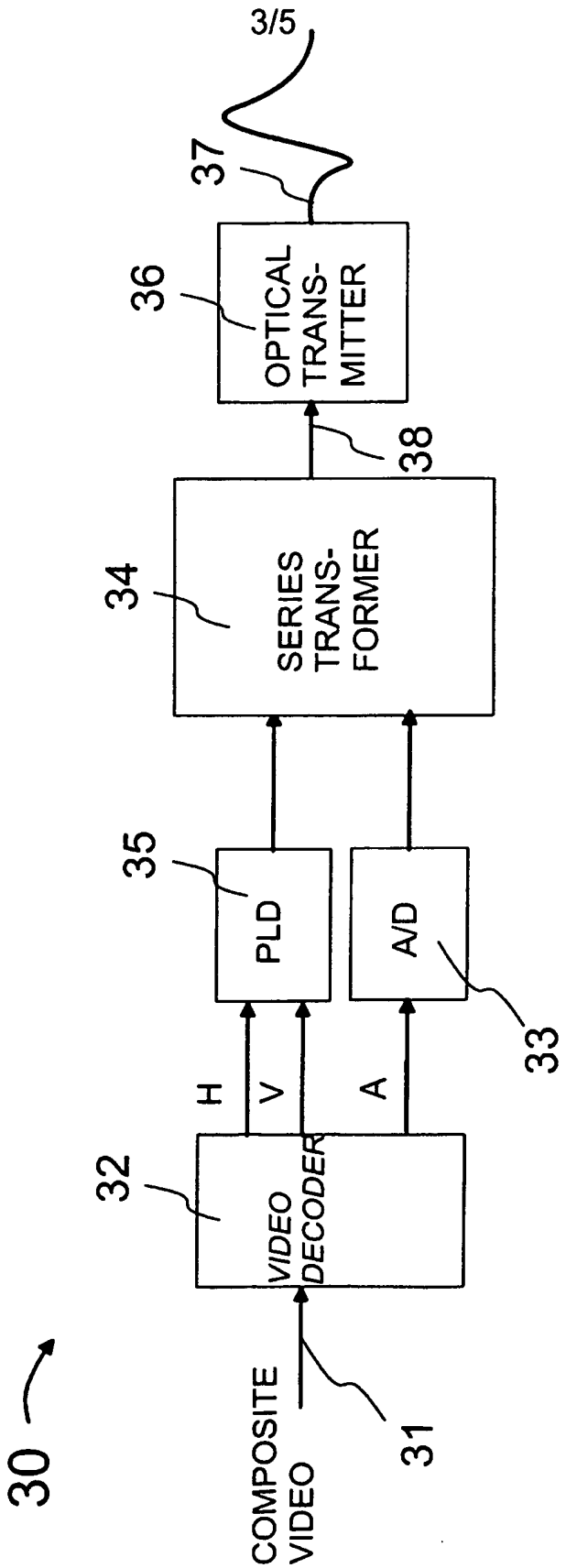
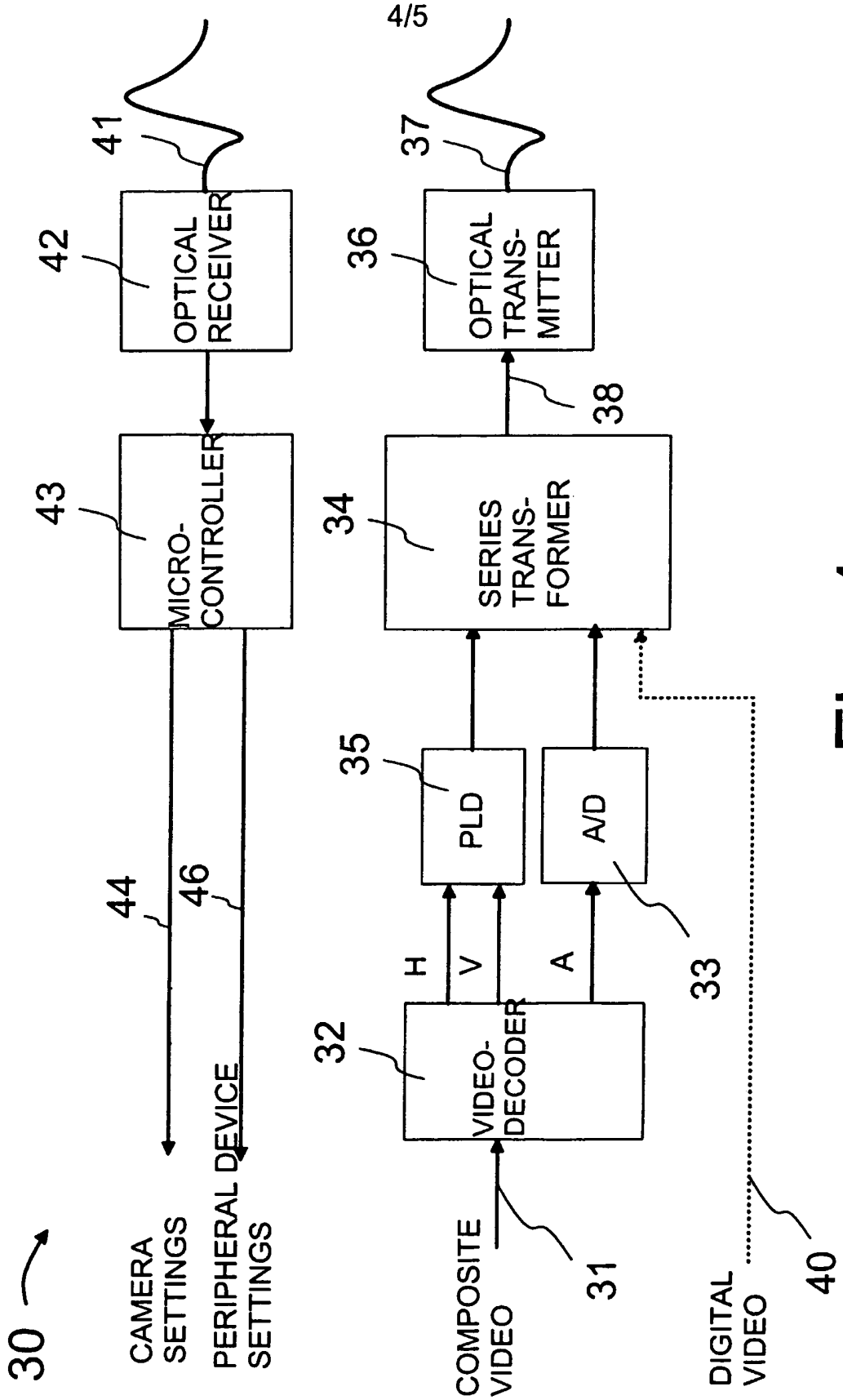

3/5
37
36
OPTICAL TRANS-MITTER
38
34
SERIES TRANS-FORMER
35
PLD
A/D
33
H
V
A
32
VIDEO DECODER
30
COMPOSITE VIDEO
31

Fig. 3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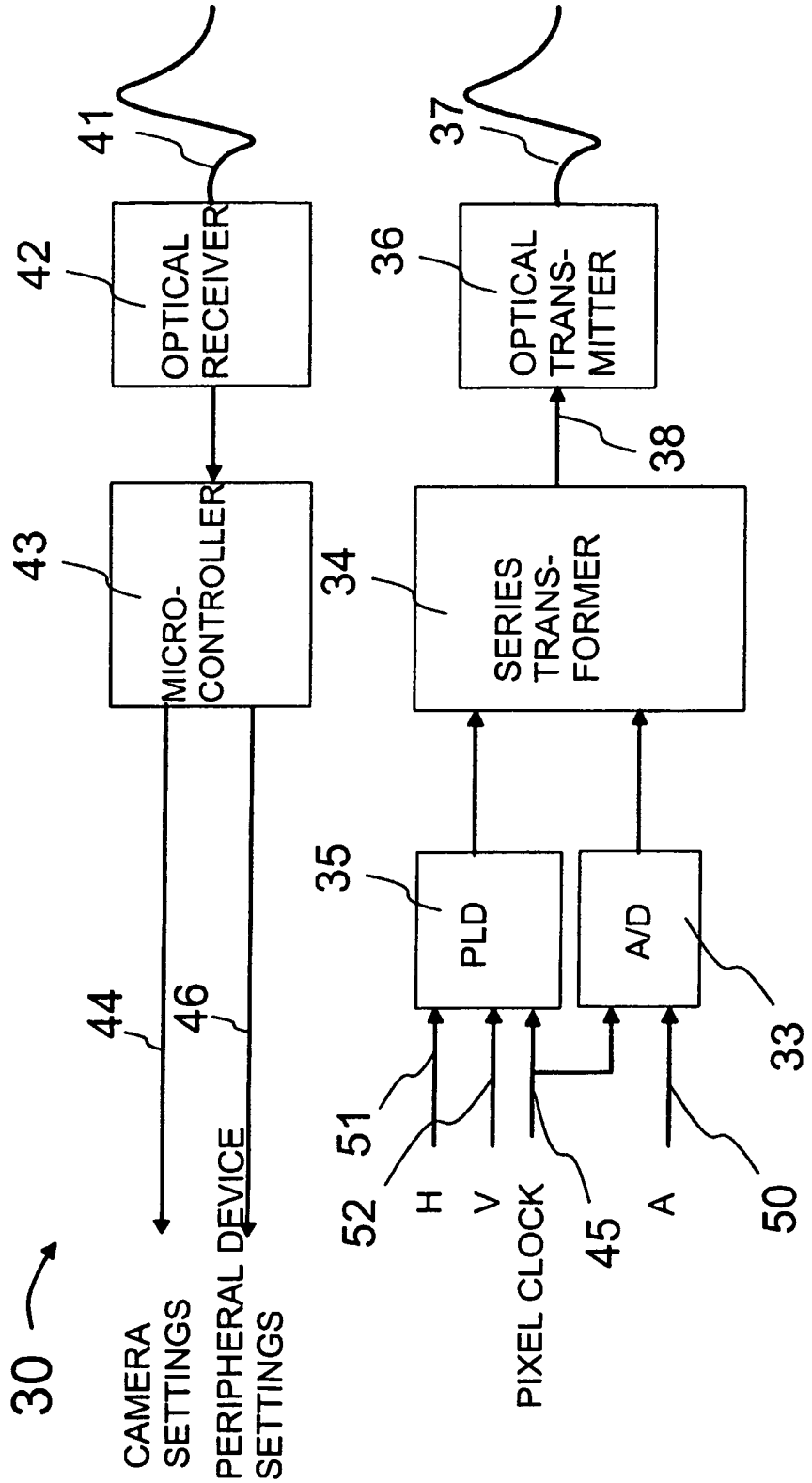
CAMERA SETTINGS
PERIPHERAL DEVICE SETTINGS
44
46
43
MICRO-CONTROLLER
42
OPTICAL RECEIVER
41
COMPOSITE VIDEO
31
32
VIDEO-DECODER
H
V
A
35
PLD
A/D
33
34
SERIES TRANS-FORMER
38
36
OPTICAL TRANS-MITTER
37
DIGITAL VIDEO
40

Fig. 4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CAMERA SETTINGS
PERIPHERAL DEVICE SETTINGS
44
46
43
MICRO-CONTROLLER
42
OPTICAL RECEIVER
41
34
SERIES TRANS-FORMER
36
OPTICAL TRANS-MITTER
37
38
35
PLD
A/D
33
52
51
H
V
PIXEL CLOCK
45
A
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Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 02/00848

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04N 7/18, G01N 21/86
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04N, G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ, INSPEC, COMPENDEX, TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5696591 A (BILHORN, R.B. ET AL), 9 December 1997 (09.12.97), column 3, line 9 - line 20; column 3, line 37 - line 39, figures 1,2, abstract --	1,3,5-6,8-11
X	EP 1033881 A2 (HILDECO OY LTD), 6 Sept 2000 (06.09.00), column 2, line 26 - line 36; column 3, line 4 - line 8, figure 1, abstract --	1,3
X	US 6266437 B1 (EICHEL, P.H. ET AL), 24 July 2001 (24.07.01), column 3, line 35 - line 42; column 6, line 66 - column 7, line 4, figure 2, abstract --	1,3

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 February 2003	28 -02- 2003
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jesper Bergstrand/LR Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 02/00848

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6259109 B1 (DALMIA, A. ET AL), 10 July 2001 (10.07.01), figure 1, claims 1,10 --	1,3,5
A	EP 0366235 A1 (PICKER INTERNATIONAL, INC), 2 May 1990 (02.05.90), whole document --	1-11
A	EP 0369585 A1 (PICKER INTERNATIONAL, INC), 23 May 1990 (23.05.90), whole document --	1-11

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/12/02

International application No.
PCT/FI 02/00848

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5696591 A	09/12/97	NONE	
EP 1033881 A2	06/09/00	CN 1267866 A	27/09/00
		FI 4396 U	27/04/00
		FI 990428 A,V	02/09/00
		JP 2000324479 A	24/11/00
US 6266437 B1	24/07/01	NONE	
US 6259109 B1	10/07/01	AU 8916498 A	16/03/99
		WO 9910833 A	04/03/99
EP 0366235 A1	02/05/90	DE 68908851 D,T	16/12/93
		DE 68922957 D,T	19/10/95
		EP 0369585 A,B	23/05/90
		JP 2121577 A	09/05/90
		JP 2141647 A	31/05/90
		JP 2955715 B	04/10/99
		JP 3091969 B	25/09/00
		US RE36047 E	19/01/99
		US 4922337 A	01/05/90
		US 4949172 A	14/08/90
EP 0369585 A1	23/05/90	DE 68908851 D,T	16/12/93
		DE 68922957 D,T	19/10/95
		EP 0366235 A,B	02/05/90
		JP 2121577 A	09/05/90
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		JP 2955715 B	04/10/99
		JP 3091969 B	25/09/00
		US RE36047 E	19/01/99
		US 4922337 A	01/05/90
		US 4949172 A	14/08/90